May 25, 1978

MEMORANDUM

To : Mr. Harl Noble, Acting Regional Director, Bureau of Reclamation, P. O. Box 11568, Salt Lake City, Utah 84111

From : Regional Director, U. S. Fish and Wildlife Service

Subject: Biological Opinion of the Effects of Glen Canyon Dam on the Colorado River as it Affects Endangered Species

On June 28, 1977, the Bureau of Reclamation formally requested Section 7 Consultation with the U. S. Fish and Wildlife Service concerning the effects of Glen Canyon Dam on endangered species in the Colorado River between Lee's Ferry and Lake Mead. Section 7 of the Endangered Species Act of 1973 states:

> "The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act. All other Federal departments and agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act and by taking such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States, to be critical."

Before Glen Canyon Dam was built in 1963, eight endemic species of fish were maintaining populations between Glen Canyon and Lake Mead:

Rhinichyhys osculus	speckled dace
Gila robusta robusta	roundtail chub
Gila cypha	humpback chub
Gila elegans	bonytail chub

Ptychocheilus lucius	Colorado squawfish
Catostomus latipinnis	flannelmouth sucker
Pantosteus discobolus	bluehead sucker
Xyrauchen texanus	razorback sucker

In addition, two other native fish species have been reported or suspected from this reach, but probably never maintained viable populations:

Lepidomeda mollispinis mollispinis	Virgin River spinedace
Plagopterus argenissimus	woundfin

Three of the above native fish species are presently listed by the Department of the Interior as endangered: Colorado squawfish, humpback chub and woundfin. In addition, the bonytail chub and razorback sucker have officially been proposed for listing in the April 24, 1978, Federal Register. Our biological opinion will deal only with those listed species (squawfish and humpback chub) that are known to have maintained viable populations in the Colorado River between Glen Canyon and Lake Mead. However, Bureau of Reclamation should be aware that if and when the bonytail chub and razorback sucker are listed, they too will come under protection of the Endangered Species Act.

Past and present distribution of Colorado squawfish and humpback chub is well documented between Lake Powell and Lake Mead, in spite of the difficulties involved with collecting in these remote areas and the fact that Gila cypha was not described until 1946 (Miller 1946). Minckley and Deacon (1967) and Minckley (1973) recorded squawfish collections from Glen Canyon, Grand Canyon (Little Colorado River and Bright Angel Creek) and a short distance upstream from Lake Mead. The last records of squawfish in this reach are two specimens from immediately below Glen Canyon Dam collected by Arizona Game and Fish personnel in 1962 through 1966 (Minckley and Deacon, 1967) and one specimen at the mouth of Shirumo Creek in 1972 (Charles Minckley, pers. comm.). Gila cypha have been recorded from prehistoric Indian sites below Hoover Dam throughout the Colorado River in the Grand Canyon and immediately below Glen Canyon Dam (Miller, 1961; Minckley, 1973). The type locality for this species is the Colorado River at the mouth of Bright Angel Creek. Although neither fish may have ever been abundant through this reach of the Colorado River, both were widespread and at one time maintained viable populations.

Recent collections of fish between Lake Powell and Lake Mead have failed to discover Colorado squawfish (Holden and Stalnaker, 1975; Minckley and Blinn, 1976; Suttkus, 1976). Gila have fared somewhat better, with moderate numbers collected in 1976, 1977, and 1978 at the confluence of the Little Colorado River and in Marble Canyon (Minckley and Blinn, 1976: Charles Minckley, pers. comm.).

It is our opinion that the major reason for the decline of both listed fish species in this reach of the Colorado River has been the abnormal water conditions that result from the operation of Glen Canyon Dam. The foremost problem has been the cold, hypolimnic waters from Lake Powell. Below Glen Canyon Dam, Cole and Kubly (1976) found annual temperatures to range between 7° and 10°C, whereas the pre-dam Colorado River showed a seasonal variation of nearly 30°C. Cole and Kubly also recorded temperatures between the two

dams for a one year period between April, 1975, and March, 1976. They found a slight warming trend downstream, but never recorded water temperatures higher than 16°C anywhere on the mainstream between Powell and Mead. The extensive canyons between the two reservoirs tend to limit solar warming of the waters. Bureau of Reclamation data (1966-1977) indiaate somewhat higher temperatures below Glen Canyon Dam, especially during the early filling period of Lake Powell (1966-1970) when some epilimnic water may have been withdrawn, but since 1970 few water temperature measurements have exceeded 10°C.

A second Colorado River parameter that operation of Glen Canyon Dam has altered is the normal fluctuations of water levels. There is no doubt that the Colorado River once showed dramatic water level fluctuations, However, this flood/drought cycle was at least partially predictable, high waters coming during the spring runoff from snowmelt in the high mountains and again in late summer during the thunderstorm season. Between these two high water periods, water levels were generally declining or stable. Demands for hydroelectric power generation at Glen Canyon Dam now result in discharges that vary by a factor of about 5 over a 24 hour cycle, resulting in a daily vertical variation of the Colorado River by as much as 15 feet (Bureau of Reclamation Environmental Assessment, 1976). The mean daily high discharge from the dam is about 20,000 cfs and the mean daily low is 4,600 cfs. Depending upon power demands, this fluctuation varies through the extremes of 27,000 cfs and 2,000 cfs in a single day.

The effects of the altered water temperature and water level fluctuations on the endangered Colorado squawfish and humpback chub are fairly clear. Vanicek and Kramer (1969) reported water temperature and receding water levels as important spawning stimuli. During the three spawning seasons they studied Colorado squawfish in the Green River, ripe fish were taken approximately one month after the water temperature had reached 18°C. Toney (1974) reported on rearing Colorado squawfish in Willow Beach National Fish Hatchery below Hoover Dam. He found ripe squawfish only after water temperatures exceeded 21°C, although the maturation process began at slightly lower temperatures. Thus it appears the cold, hypolimnic waters issuing from Glen Canyon Dam do not attain temperatures that allow the Colorado squawfish to spawn (18-21°C) anywhere in the Colorado River between Lake Powell and Lake Mead.

Gila appear to mature at slightly lower temperatures, as the fish Vanicek and Kramer (1969) studied were found to be ripe at 18°C. As this temperature is not now reported in the mainstream Colorado River between the two reservoirs, humpback chub spawning appears to be limited to the proximity of inflowing streams where warmer water may provide minimal spawning requirements, either by tempering the mainstream for short distances or allowing the fish to enter the tributaries and escape the colder, mainstream waters, The Little Colorado River provides 27% of the water inflow into the Colorado River between the two reservoirs, but accounts for less than 3% of the total flow below that point (Bureau of Reclamation Environmental Analysis, 1976). In any case, the

only remnant population of Gila cypha known to exist between the two reservoirs inhabits the Colorado and Little Colorado rivers around their confluence.

Effects of the constant fluctuations of water levels may also be dampened by the tributary inflows, but only humpback chubs seem able to survive the existing conditions. Further information on habitat requirements of the two listed species are needed, as is the relationship between mainstream and tributary habitats and the general movement of fish in the tributary areas. The language of Section 7 is quite specific about Federal actions affecting listed species and critical habitat (actions authorized, funded or carried out should not jeopardize the continued existence of listed species or result in the destruction or modification of critical habitat). The Colorado River Fishes Recovery Team recommended the Colorado River between the Little Colorado River and Diamond Creek as critical habitat for the squawfish in 1975 and for Gila cypha in 1977. This reach has not been included in the final squawfish critical habitat proposal because the species is presently believed to be extirpated there. There is little doubt the Colorado River around the mouth of the Little Colorado will be included in the upcoming Gila cypha critical habitat proposal, as only two other small areas in the drainage are presently known to support this species.

Additional Information

In September, 1977, the National Park Service sent out a Natural Resources Management Plan that included suggestions for the Grand Canyon portion of the Colorado River (National Park Service, 1977). This plan included the following:

> "Explore economic, biological, political and time elements toward a plan of restoring the Colorado River and its tributaries to be more conducive to native fish. Though massive change has occurred in park riparian habitat because of Glen Canyon Dam, it may be possible to mitigate some impacts by raising the water intake of the generating penstocks to allow for warmer water to pass through the dam."

In reply to this suggestion, the Arizona Department of Game and Fish, in a letter to the National Park Service dated February 16, 1978, stated:

> "The Grand Canyon National Park's 'Natural Resources Plan' calls for manipulations of the Colorado River below Glen Canyon Dam which would result in a substantial change in the ecosystem of the river between Glen Canyon Dam and Lake Mead. The stated purpose of the alterations is to enhance this portion of the river for endangered fishes. While the Arizona Game and Fish Department agrees that enhancement of endangered species habitat is a laudable objective, we feel that the methods proposed, i.e., raising the water temperature of the river, limiting sport fishing to fly only and cessation of trout stocking programs, will not

accomplish the desired results. Conversely, raising the water temperature of the river will allow exotic fishes now found in Lake Powell and Lake Mead to expand into the area where they are absent, or present in limited numbers due to the low water temperatures. The resulting presence of these exotic species will place more stress on the endangered species through increased predation and competition, than do the trout which presently occupy this portion of the river."

The question the State of Arizona did not raise is if the potential influx of exotic species would be more damaging to endangered species than the existing water temperatures and water fluctuations?

Biological Opinion

Incorporating all of the above information, it is the biological opinion of the U. S. Fish and Wildlife Service that:

1. Past, present and proposed future operations of Glen Canyon Dam have had, are having and will have an adverse affect on the essential habitat of the endangered humpback chub and is jeopardizing the continued existence of this species by limiting its distribution and population size.

2. The operation of Glen Canyon Dam is modifying a major portion of the known Gila cypha habitat and is limiting the ability of this endangered species to recover from its presently reduced state.

3. Operation of Glen Canyon Dam is limiting the recovery of Colorado squawfish by altering and rendering unsuitable that reach of the Colorado River between Lake Powell and Lake Mead once known to support this endangered species.

Suggestions

It appears there are several alternatives available to reduce or eliminate the present and future jeopardy to endangered species resulting from the operation of Glen Canyon Dam. However, the problems suggested by the State of Arizona seem real enough for us not to recommend alterations in the Dam operation until the impacts of this action are more clearly known. We, therefore, recommend instead that the Bureau of Reclamation fund specific, long-term studies on the following:

1. The potential impact of warming the river below Glen Canyon Dam on endangered species. The data presently being gathered by the Bureau of Reclamation on the new multiple penstock operation at Flaming Gorge Dam should provide an excellent starting point for this study.

2. The ecological needs of the endangered species in the Colorado River between Glen Canyon Dam and Lake Mead.

3. Methods of reducing or eliminating the known constraining factors of low water temperature and frequent water flow fluctuations on endangered species.

4. The relationship between mainstream and tributary habitats and their utilization by endangered species.

The Service will be pleased to meet with the Bureau to evaluate the present options available to you and assist in planning the above studies. One of the major goals of the draft Colorado Squawfish Recovery Plan is to restore the species to portions of their former range. The goal is also being incorporated into the Humpback Chub Recovery Plan presently being prepared. In order to achieve these goals, close cooperation between several Federal agencies involved in managing the Colorado River will be necessary. An excellent start towards recovery of these species and their eventual removal from the Endangered Species List would be the recovery of the Colorado River below Glen Canyon Dam. We hope this goal is possible, and are willing to work with the Bureau of Reclamation in any way possible in order to achieve it.

(SGD) W. O. NELSON, JR.

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Literature Cited

Bureau of Reclamation Environmental Analysis. 1976. Operation of Glen Canyon Dam and Lake Powell, Colorado River Storage Project, Arizona - Utah. (Draft). Upper Colorado Region, Bureau of Reclamation, Salt Lake City, Utah. 180 pp.

Cole, G. and D. M. Kubly. 1976. Limnological Studies on the Colorado River from Lee's Ferry to Diamond Creek. Report Series, Grand Canyon National Park. Technical Report No. 8. 88 pp.

Holden, P. B. and C. B. Stalnaker. 1975. Distribution and Abundance of Mainstream Fishes of the Middle and Upper Colorado River Basins, 1967-73. Trans. Amer. Fish. Soc. 104(2): 217-231.

Miller, R. R. 1946. Gila cypha, A Remarkable New Species of Cyprinid Fish from the Colorado River in Grand Canyon, Arizona. J. Wash. Acad. Sci. 36(12):409-415.

Miller, R. R. 1961. Man and the Changing Fish Fauna of the American Southwest. Pap. Mich. Acad. Sci., Arts, Lett. 46:365-404.

Minckley, C. OL and D. W. Blinn. 1976. Summer Distribution and Reproductive Status of Fish of the Colorado River in Grand Ganyon National Park and Vicinity, 1975. Report Series, Grand Canyon National Park. Technical Report No. 14. 17 pp.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 293 pp.

Minckley, W. L. and J. E. Deacon. 1969. Southwestern Fishes and the Enigma of "Endangered Species." Science 159:1424-1432.

National Park Service. 1977. Grand Canyon National Park, Arizona. Natural Resource Management Plan and Environmental Assessment. Grand Canyon, Arizona. 127 pp.

Suttkus, R. D., G. H. Clemmer, C. Jones and C. R. Shoop. 1976. Survey of Fishes, Mammals and Herpetofauna of the Colorado River in Grand Canyon, Report Series, Grand Canyon National Park. Technical Report No. 5. 48 pp.

Toney, D. P. 1974. Observations on the propagation and Rearing of Two Endangered Fish Species in a Hatchery Environment. Proc. West. Assoc. State Game and Fish Comm. 54:252-259.

Vanicek, C. D. and R. H. Kramer. 1969. Life History of the Colorado squawfish, Ptychocheilus lucius, and the Colorado chub, Gila robusta, in the Green River in Dinosaur National Monument, 1964-1966. Trans. Amer. Fish. Soc. 98(2):193-208. (Note: The fish described as Gila robusta now includes Gila cypha and G. elegans.)